Direct determination of the electrophoretic mobility of individual micro- and nanoparticles

Íngrid Amer Cid[1], Kristiaan Neyts[1], Filip Strubbe[1].

[1] Liquid Crystal and Photonics Group (LCP), Department of Electronics and Information systems (ELIS), Ghent University, Technologiepark 126, Zwijnaarde, Belgium.

Micro- and nanoparticles are increasingly used in a variety of biomedical applications, such as drug delivery or biomedical detection. Knowledge on a particle-to-particle basis of the surface charge is useful for detailed characterization of particles and their interaction with the environment, for example, in biosensing, nanocarrier engineering and in studies of protein corona. One approach to characterize the electrical properties of individual particles is to measure the electrophoretic mobility in a microchannel. However, the electroosmotic flow (EOF) complicates such measurements and can be a source of error.

Here, we present an analytical technique which minimizes the contribution of EOF such that the electrophoretic mobility of micro- and nanoparticles can be directly measured on a particle-to-particle basis. In our approach we use a custom-built inverted microscope combined with a fast CMOS camera. Particles are dispersed in a microfluidic cell and illuminated with an LED. Only particles situated near the center of the cross-section of the microfluidic channel are measured. An AC field is applied, and particle displacements are recorded at a high frame rate. Image analysis is performed in post-processing to extract the electrophoretic mobility.

Simulations based on Navier-Stokes equations show that in the middle of a 400 µm high fluidic channel (ibidi µ-Slide VI 0.4, length 17 mm, width 3.8 mm) and at an applied AC frequency above 200 Hz, the contribution of EOF becomes negligible, allowing to directly measure the electrophoretic mobility. The approach is demonstrated for 500 nm particles on a particle-to-particle basis. The accuracy of the electrophoretic mobility values is analyzed by comparing particle mobility values at different AC frequencies and locations in the channel to the theory.